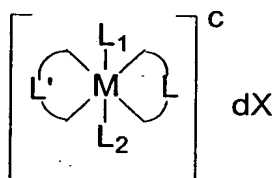


CLAIMS

1. A transition metal complex having the formula:



wherein c is a negative, neutral, or positive charge represented by -1 to -5, 0, or +1 to +5, respectively;

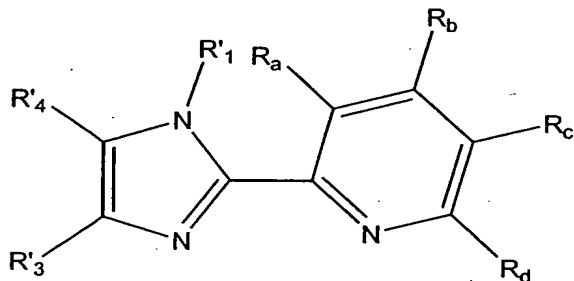
d is an absence or a number of counter ions X represented by 0 or 1 to 5, respectively;

M is cobalt, iron, osmium, ruthenium, or vanadium;

L_1 is a substituted or an unsubstituted heterocyclic nitrogen-containing ligand;

L_2 is a negatively charged ligand; and

L and L' are independently selected from a group consisting of:



wherein R'_1 is a substituted or an unsubstituted alkyl, alkenyl, or aryl;

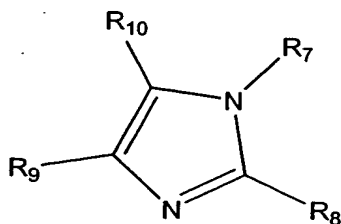
R_a and R_b are independently -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -SO₃H, -NHNH₂, -SH, -OH, -NH₂, or substituted or unsubstituted alkoxycarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxylamino, alkylthio, alkenyl, aryl, or alkyl;

R'_3 , R'_4 are independently -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -SO₃H, -NHNH₂, -SH, -OH, -NH₂, or substituted or unsubstituted alkoxycarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxylamino, alkylthio, alkenyl, aryl, or alkyl, or a combination of R'_3 and R'_4 forms a saturated or unsaturated 5- or 6-membered ring; and

R_c, and R_d are independently -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -SO₃H, -NHNH₂, -SH, -OH, -NH₂, or substituted or unsubstituted alkoxycarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxylamino, alkylthio, alkenyl, aryl, or alkyl, or a combination of R_c and R_d forms a saturated or unsaturated 5- or 6-membered ring.

2. The complex of claim 1, wherein R'₁ is a substituted or unsubstituted C1-C12 alkyl or alkenyl.
3. The complex of claim 1, wherein R'₁ is methyl.
4. The complex of claim 1, wherein R'₁ is a substituted or unsubstituted aryl.
5. The complex of claim 1, wherein R'₁ is a substituted or unsubstituted phenyl.
6. The complex of claim 1, wherein R'₁ is a phenyl substituted with a substituent selected from a group consisting of -Cl, -F, -CN, amino, carboxy, C1-C6 alkyl, C1-C6 alkylthio, C1-C6 alkylamino, C1-C6 dialkylamino, C1-C6 alkylaminocarbonyl, C1-C6 alkoxy, C1-C6 alkoxycarbonyl, and C1-C6 alkylcarboxamido.
7. The complex of claim 1, wherein R'₃, R'₄, R_a, R_b, R_c, and R_d are independently -H or substituted or unsubstituted alkyl.
8. The complex of claim 1, wherein c is 0, +1, +2, or +3.
9. The complex of claim 1, wherein X is an anion selected from a group consisting of halides, sulfates, phosphates, hexafluorophosphates and tetrafluoroborates.
10. The complex of claim 1, wherein X is chloride.
11. The complex of claim 1, wherein d is 2.
12. The complex of claim 1, wherein L₁ is a derivative of any of imidazole, triazole, oxazole, thiazole, and pyrazole.

13. The complex of claim 1, wherein L_1 has the formula:



wherein R_7 is a substituted or an unsubstituted alkyl, alkenyl, or aryl;

R_8 is -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -SO₃H, -NHNH₂, -SH, -OH, -NH₂, alkoxy, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxyamino, alkylthio, alkenyl, aryl, or alkyl; and

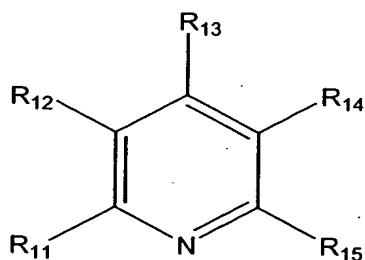
R_9 and R_{10} are independently -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -SO₃H, -NHNH₂, -SH, -OH, -NH₂, alkoxy, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxyamino, alkylthio, alkenyl, aryl, or alkyl, or a combination of R_9 and R_{10} forms a fused, saturated or unsaturated, 5- or 6-membered ring.

14. The complex of claim 13, wherein R_7 is a substituted or unsubstituted C1-C12 alkyl or alkenyl.

15. The complex of claim 13, wherein R_9 and R_{10} form a fused, unsaturated 6-membered ring.

16. The complex of claim 13, wherein R_8 , R_9 and R_{10} are independently -H or substituted or unsubstituted alkyl.

17. The complex of claim 1, wherein L_1 has the formula:



wherein R_{11} , R_{12} , R_{13} , R_{14} and R_{15} are independently -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -OH, -NH₂, alkoxycarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxyamino, alkylthio, alkenyl, aryl, or alkyl.

18. The complex of claim 17, wherein at least one of R_{11} , R_{12} , R_{13} , R_{14} and R_{15} is an alkyl substituted with -F, -Cl, -Br, -I, alkylamino, dialkylamino, trialkylammonium, alkoxy, alkylthio, aryl, or a reactive group, or an aryl substituted with -F, -Cl, -Br, -I, alkylamino, dialkylamino, alkoxy, alkylthio, aryl, or a reactive group.

19. The complex of claim 17, wherein R_{11} , R_{12} , R_{13} , R_{14} and R_{15} are independently -H, methyl, C1-C2 alkoxy, C1-C2 alkylamino, C2-C4 dialkylamino, or a C1-C6 alkyl substituted with a reactive group.

20. The complex of claim 1, wherein L_2 is selected from a group consisting of -CN, -SCN, -OH, halide, alkoxy, alkylthio, and phenoxide.

21. The complex of claim 1, wherein L_2 is chloride.

22. The complex of claim 1 having a redox potential of from about 0 mV to about -200 mV relative to a Ag/AgCl reference electrode.

23. The complex of claim 1, wherein M is osmium.

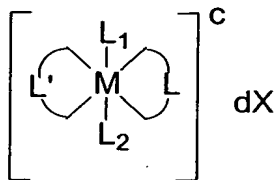
24. The complex of claim 1, wherein at least one of L, L', L_1 and L_2 is coupled to a polymeric backbone.

25. The complex of claim 24, wherein the polymeric backbone comprises at least one functional group that is a ligand of the complex.

26. The complex of claim 25, wherein the functional group is selected from a group consisting of pyridine and imidazole groups.

27. The complex of claim 1, wherein said complex is a polymeric product of a reaction of a precursor polymer and a precursor transition metal complex.

28. A transition metal complex having the formula:



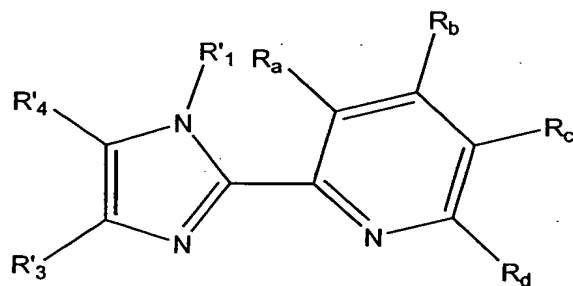
wherein c is a neutral or positive charge represented by 0, or +1 to +3, respectively;
d is absence or a number of counter anions X represented by 0 or 1 to 5, respectively;

M is osmium;

L₁ is a substituted or an unsubstituted heterocyclic nitrogen-containing ligand;

L₂ is from a group consisting of -CN, -SCN, -OH, halide, alkoxy, alkylthio, and phenoxide; and

L and L' are independently selected from a group consisting of:



wherein R'1 is a substituted or an unsubstituted C1-C12 alkyl; and

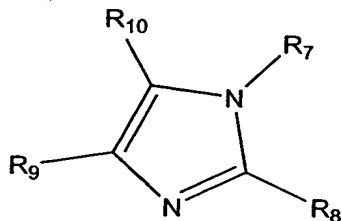
R'3, R'4, R_a, R_b, R_c, and R_d are independently -H or substituted or unsubstituted alkyl.

29. The complex of claim 28, wherein X is an anion selected from a group consisting of halides, sulfates, phosphates, hexafluorophosphates and tetrafluoroborates.

30. The complex of claim 28, wherein L₂ is selected from a group consisting of -CN, -SCN, -OH, halide, alkoxy, alkylthio, and phenoxide.

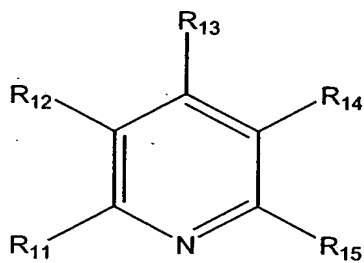
31. The complex of claim 28, wherein L₁ is a derivative of any of imidazole, triazole, oxazole, thiazole, and pyrazole.

32. The complex of claim 28, wherein L_1 has the formula:



wherein R_7 is a substituted or an unsubstituted C1-C12 alkyl or alkenyl; and R_8 , R_9 and R_{10} are independently -H or substituted or unsubstituted alkyl.

33. The complex of claim 28, wherein L_1 has the formula:



wherein R_{11} , R_{12} , R_{13} , R_{14} and R_{15} are independently -H, methyl, C1-C2 alkoxy, C1-C2 alkylamino, C2-C4 dialkylamino, or a C1-C6 alkyl substituted with a reactive group.

34. The complex of claim 28 having a redox potential of from about 0 mV to about -200 mV relative to a Ag/AgCl reference electrode.

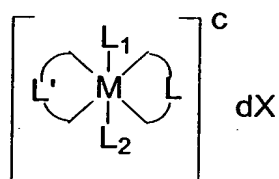
35. The complex of claim 28, wherein at least one of L , L' , L_1 and L_2 is coupled to a polymeric backbone.

36. The complex of claim 35, wherein the polymeric backbone comprises at least one functional group that is a ligand of the complex.

37. The complex of claim 36, wherein the functional group is selected from a group consisting of pyridine and imidazole groups.

38. The complex of claim 28, wherein said complex is a polymeric product of a reaction of a precursor polymer and a precursor transition metal complex.

39. A sensor comprising:
a working electrode;
a counter electrode;
a redox mediator disposed proximate to the working electrode, the redox mediator having the formula:



wherein c is a negative, neutral, or positive charge represented by -1 to -5, 0, or +1 to +5, respectively;

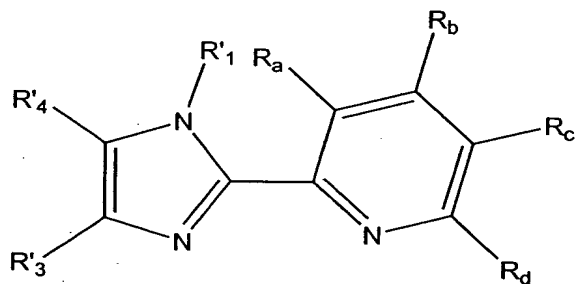
d is an absence or a number of counter ions X represented by 0 or 1 to 5, respectively;

M is cobalt, iron, osmium, ruthenium, or vanadium;

L₁ is a substituted or an unsubstituted heterocyclic nitrogen-containing ligand;

L₂ is a negatively charged ligand; and

L and L' are independently selected from a group consisting of:



wherein R'₁ is a substituted or an unsubstituted alkyl, alkenyl, or aryl;

R_a and R_b are independently -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -SO₃H, -NHNH₂, -SH, -OH, -NH₂, or substituted or unsubstituted alkoxycarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxylamino, alkylthio, alkenyl, aryl, or alkyl;

R'₃, R'₄ are independently -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -SO₃H, -NHNH₂, -SH, -OH, -NH₂, or substituted or unsubstituted alkoxycarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxylamino, alkylthio, alkenyl, aryl, or alkyl, or a combination of R'₃ and R'₄ forms a saturated or unsaturated 5- or 6-membered ring; and

R_c , and R_d are independently -H, -F, -Cl, -Br, -I, -NO₂, -CN, -CO₂H, -SO₃H, -NHNH₂, -SH, -OH, -NH₂, or substituted or unsubstituted alkoxycarbonyl, alkylaminocarbonyl, dialkylaminocarbonyl, alkoxy, alkylamino, dialkylamino, alkanoylamino, arylcarboxamido, hydrazino, alkylhydrazino, hydroxylamino, alkoxylamino, alkylthio, alkenyl, aryl, or alkyl, or a combination of R_c and R_d forms a saturated or unsaturated 5- or 6-membered ring.

40. The sensor of claim 39, wherein c is a neutral or positive charge represented by 0, or +1 to +3, respectively; M is osmium; L_2 is selected from a group consisting of -CN, -SCN, -OH, halide, alkoxy, alkylthio, and phenoxide; R'_1 is a substituted or an unsubstituted C1-C12 alkyl; and R'_3 , R'_4 , R_a , R_b , R_c , and R_d are independently -H or substituted or unsubstituted alkyl groups.

41. The sensor of claim 39, further comprising an enzyme disposed proximate to the working electrode.

42. The sensor of claim 39, wherein the redox mediator has a redox potential of from about 0 mV to about -200 mV relative to a Ag/AgCl reference electrode.

43. The sensor of claim 39, wherein the redox mediator is coupled to a polymeric backbone via at least one of L , L' , L_1 and L_2 .

44. The sensor of claim 43, wherein the polymeric backbone comprises at least one functional group that is a ligand of the complex.

45. The sensor of claim 44, wherein the functional group is selected from a group consisting of pyridine and imidazole groups.

46. The sensor of claim 39, wherein said complex is a polymeric product of a reaction of a precursor polymer and a precursor transition metal complex.

47. The sensor of claim 39, wherein the redox mediator is crosslinked on the working electrode.

48. The sensor of claim 39, wherein the redox mediator and an enzyme are crosslinked on the working electrode.